A RECENTLY OBSERVED INCREASE IN DISTRIBUTION OF THE DESERT MOUSE, *PSEUDOMYS DESERTOR*, IN WESTERN AUSTRALIA

By N.K. COOPER
Western Australian Museum, Locked Bag 49,
Welshpool, WA 6986

R.J. TEALE
Biota Environmental Sciences, 14 View St,
North Perth, W.A. 6906

and P.G. KENDRICK
Department of Environment and Conservation,
Karratha, W.A. 6714

ABSTRACT

As a result of extensive trapping since 1997 in Western Australia, the current range of *Pseudomys desertor* is more completely known including records from areas where previously only subfossil remains were known. The known range of *P. desertor* has now been extended by 1000 kilometres westward and south by 200kms. These animals were trapped in areas where previous intensive sampling had failed to capture them. This apparent extension of extant geographic range of *P. desertor* may be a consequence of an irruption of this previously uncommon species in response to good seasons, thus becoming more abundant, widespread and conspicuous.

INTRODUCTION

The Desert Mouse, *Pseudomys desertor*, is a native Australian rodent, which in places is sympatric with the Western Chestnut Mouse, *P. nanus*. The two species are similar in appearance and can be difficult to distinguish in the hand (Cooper *et al.* 2006).

Until recently, the extant distribution of *Pseudomys desertor* was considered to cover only the arid Australian interior and semi-arid tropics in the Northern Tanami, Northern Territory and east Kimberley of Western Australia (Kerle 1995). The only record in New South Wales was in 1856-7, when it was collected along the Murray River. It is now considered extinct in that state. In Western Australia, it was

collected from Bernier Island (24°56'S; 113°08'E) in 1910, although it is now extinct there (Baynes 1990, McKenzie *et al.* 2000), and subfossil remains have been found at Cape Range, Shark Bay, the Nullarbor Plain and the south-western Kimberley (A. Baynes *pers. comm.*). The current recorded distribution, prior to this publication, ranges from central Western Australia, across the Northern Territory and South Australia, and through much of Queensland (Western Australian Museum 2003).

In an early summary of this species, Happold (1983) considered *P. desertor* rare and possibly endangered, particularly in Western Australia. This was revised by Kerle (1995), who considered this species to be 'secure and widespread in arid areas'. Read *et al.* (1999) believed *P. desertor* to be secure in the north-western arid zone of South Australia, although Dickman *et al.* (2000) believed that in Queensland, *P. desertor* had a large range but with small or declining populations.

This paper demonstrates that *P. desertor* is widespread and at times common in Western Australia. From analysis of the number of specimens lodged at the Western Australian Museum (WAM) and others captured and released in the field and habitat descriptions and analysis of rainfall records, a speculative discussion on recent population fluctuations and range extensions in *P. desertor* has become possible.

MATERIALS

Information on specimens collected was obtained from the Mammal Specimen Database of the WAM, and from data collected by field biologists and from environmental reports and scientific publications produced between the years 1980 to 2002.

Both pit-fall and Elliott traps were used in all trapping surveys, and some specimens were observed or captured while foraging.

Rainfall data were obtained from the Bureau of Meteorology.

RESULTS

Figure 1 shows the distribution records of *P. desertor* in Western Australia from the WAM mammal specimen database, and results from recent collecting surveys carried out in the Pilbara and further south by environmental companies and the Western Australian Department of Conservation and Land Management (CALM) staff. Pale shading indicates the subfossil distribution (A. Baynes *pers. comm.*) of *P. desertor*; the dark shading indicates the currently recognised distribution (after Kerle 1995).

HABITAT

There has been little previous documentation of habitats from which *P. desertor* have been collected in Western Australia. Table 1 summarises available

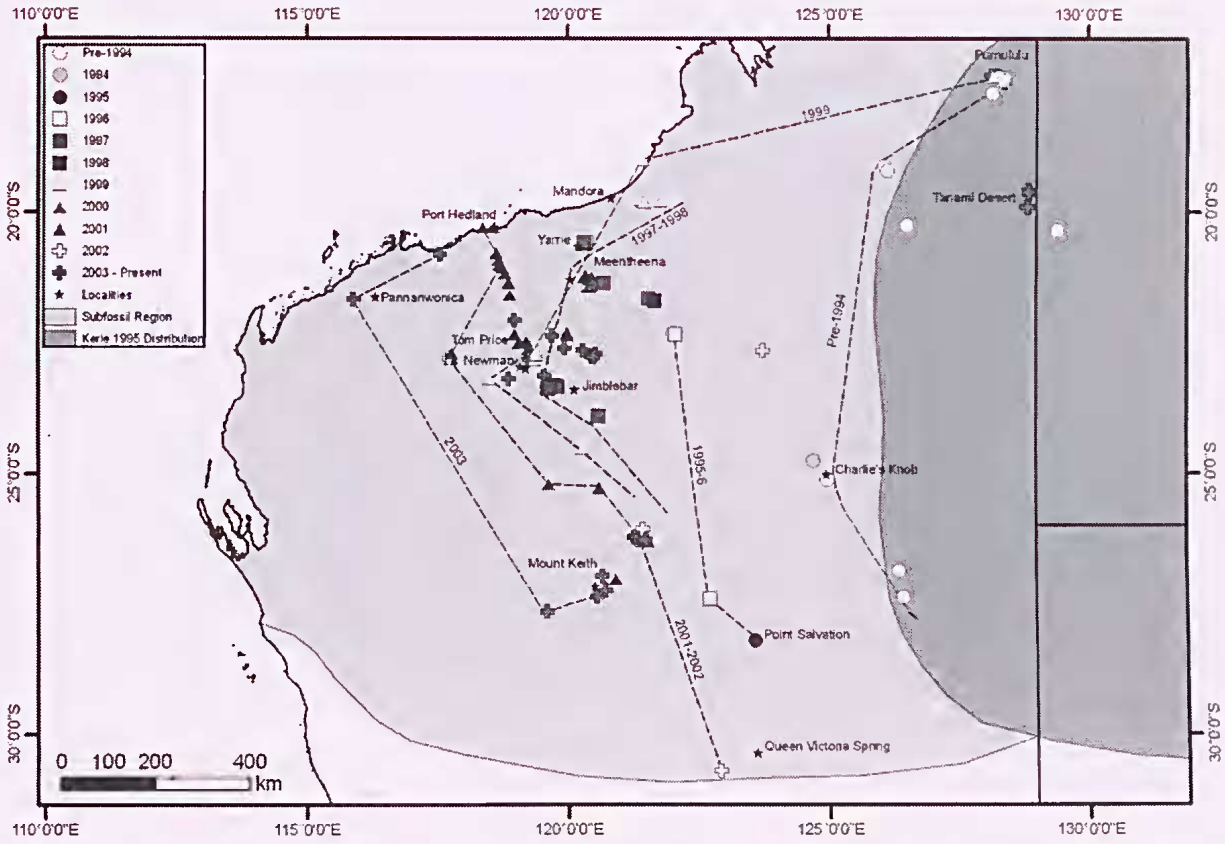

Figure 1. Distribution records of *P. desertor* in Western Australia coded by year of capture. Pale shading indicates the subfossil distribution (A. Baynes *pers. comm.*) of *P. desertor*; the dark shading indicates the currently recognised distribution (after Kerle 1995).

Table 1. Habitat descriptions for sites in Western Australia where *P. desertor* has been captured.

Location	Latitude, Longitude	Habitat	Source
Hope Downs to Port Hedland rail corridor	22°58'S; 119°08'E to 20°18'S; 118°35'E	Clayey sand plains, stony colluvial plains and cracking clays, with Acacia and other shrub lands over various species of *Triodia* (*T. angusta*, *T. basedowii*, *T. brizoides*, *T. epactia* , *T. lanigera* and *T. longiceps*), and bunch grasses.	Biota 2002.
Yarrie	20°35'S; 120°31'E	Dense tall shrubland (3–4 m high) of *Acacia tumida* over dense *Triodia pungens*;. scattered *Grevillea wickhamii*, *Tephrosia virens* and *Templetonia hookeri*, common *Euc. odontocarpa*, occasional *Corymbia hamersleyana*; sparse low shrubs including *Dampiera candicans*, seedlings of *Acacia tumida* ,occasional *Acacia ptychophylla* intruding from the surrounding steppe, dense cover of *Triodia pungens* (hummocks to 1m); drainage lines up to 20m in width; soil in the drainage lines shallow sandy loam with a soft setting surface, elsewhere on the plateau soils typically skeletal with occasional outcrops of ironstone.	Halpern, Glick Maunsell 1998.
West Angelas	23°12'S; 118°34'E	*Acacia aneura* woodland over *Triodia pungens*, mixed shrubs on loamy soils; burnt drainage area, with dense regenerated shrub layer over herbs, chenopods and grasses.	ecologia 1998

Meentheena	21°17'S; 120°28'E	A variety of alluvial, colluvial and rocky surface types associated with the Abydos Plain and the Nullagine River. These include alluvial units along the Nullagine River, colluvial slopes and flats (usually stony clays), rocky hill tops and ridges, granite rockpiles and plains, and carbonate limestone hills. Most areas supported *Triodia* (*T. wiseana, T. angusta and T. pungens*). Alluvial deposits supported *Acacia ampliceps* and *Corymbia hamersleyana*, with *Euc. victrix* and *Acacia coriacea* in creeklines, over heavy buffel grass (*Cenchrus ciliaris*). On stony uplands, more open Triodia grew beneath scattered *Euc. leucophloia, Corymbia ferriticola*, with *Euc. victrix* and *Terminalia canescens* over mixed grasses in creeklines. *Triodia* dominates stony and sandy clay flats, with a light overstory of *Corymbia hamersleyana, Acacia ancistrocarpa, A. farnesiana, A. inequilatera*, and with *Euc. leucophloia* on hillsides. Creeklines contain *Euc. victrix* and *Terminalia canescens* over *Cenchrus ciliaris* and native bunch grasses.	Kendrick, unpublished.
Mandora	19°44'S; 120°50'E	Red to orange sand plains with parallel dunes, with *Triodia pungens* (burnt within the last 3 years), and scattered *Acacia ancistrocarpa, A. translucens, Melaleuca lasiandra, Grevillea stenobotrya, G. eriostachya* and *G. pyramidalis*. Sandy loam areas with *Triodia pungens* under a dense to open canopy of *Acacia ampliceps, A. bivenosa, A. translucens, Melaleuca glomerata* and *Grevillea wickhamii*. These overstory patches varied greatly in density and were very patchy. Open areas were mostly *Triodia pungens*.	Kendrick, unpublished.

descriptions of areas where *P. desertor* has been collected in recent years.

Pseudomys desertor are known from a wide range of habitat types in the Pilbara. They were commonly recorded from hummock grasslands (various *Triodia* species), with or without shrub (various *Acacia*, *Grevillea* and others) or tree (*Acacia aneura*, various *Eucalyptus* or *Corymbia*) overstory. They were also recorded from mulga (*Acacia aneura*) woodlands over *Triodia*, chenopods and grasses, from stony and clayey granite plains, granite rockpiles, rocky limestone hills almost without soil, and from along river flood-plains and creeklines now dominated by Buffel Grass (*Cenchrus ciliaris*). To the north of the Pilbara at Mandora, *P. desertor* was taken from red sand ridges and swales, and from sandy loam areas near Lake Walyarta (mostly with *Triodia pungens* and various shrubs).

DISTRIBUTION

Prior to 1992, eight records of *Pseudomys desertor* were known from the Pilbara, and six from the Kimberley (WAM collection). Between 1992 and 1996, five specimens of *P. desertor*, including one from the most southerly locality, Point Salvation, (28°12'S; 123°36'E), were collected in Western Australia (Figure 1). During the next 5 years (1997–2002), consultant and CALM biologists have lodged 79 specimens of *P. desertor* with the WAM. These specimens, from localities ranging from Mandora (19°47.5'S; 121°27'E) to Tom Price (22°49'S; 117°45'E) have extended the known range of *P. desertor* by 1000 kilometres westward from Charlies Knob (25°07.5'S; 125°00'E), and south by 200kms to Point Salvation (28°12'S; 123°36'00"E: Figure 1). In 2005, the most western record of *P. desertor* was collected at Pannawonica (21°39'S; 116°20'E). Alpers *et al.* (2003) recorded *P. desertor* at Queen Victoria Spring, in the Great Victoria Desert (30°04'S; 122°55.5'E), a further 190 kilometres south from Point Salvation.

A RECENT HISTORY OF *P. DESERTOR* COLLECTIONS IN THE PILBARA.

Numerous trapping studies have been conducted throughout the Pilbara Bioregion, mainly by consultant biologists assessing environmental impacts of proposed industrial developments (Biota 2001). In combination with older trapping programs, some of these studies suggest an apparent recent expansion of *P. desertor* from refugia and/or an increase in range within the Pilbara during the period 1992–2002 (Table 2). This apparent change in status and range is indicated by a prevalence of recent trapping success from general areas, or specific sites, where no previous records (apart from subfossil material) of *P. desertor* have been

Table 2. *P. desertor* capture results from systematic trapping in the Pilbara region of Western Australia, pit trap and Elliott trap numbers combined.

Year	Location	Latitude; Longitude	Number of trap nights	Number of *P. desertor*	% animals per trap	Source
1988–1990	Abydos – Woodstock	21°40'S; 119°00'E:	10615	0	0	How and Cooper 2002
2000–2001	10km W Woodstock	20°18'S; 118°35'E	1550	7	0.45	R. Teale, unpublished
1979–1980	Karijini Nat Park	22°35'S; 118°27'E,	6333	0	0	Dunlop and Sawle 1980
1991–1995	Karijini Nat Park	22°35'S; 118°27'E,	6206	0	0	Kendrick unpublished
1993–1997	Yarrie – Newman Rail	33°43'S; 121°35'E	14000	0	0	R. Teale, unpublished
1994–1996	Jimblebar	23°28'S; 123°11'E	15000	0	0	Endersby 1994
1993–1995	Yarrie Plateau	20°41'S; 120°12'E	400 plus	0	0	M. Piggott, *pers. comm.*
1996	Yarrie Plateau	20°41'S; 120°12'E	3445	11	0.32	R. Teale, unpublished
1997	Yarrie Plateau	20°41'S; 120°12'E	2400	17	0.81	R. Teale, unpublished
1995	Ore Body 18	23°19'S; 120°03'E	1199	0	0	Ecologia 1995a
1995	Ore Body 25	23°19'S; 119°49'E	unknown	0	0	Ecologia 1995b
1997	Ore Body 25	23°19'S; 119°49'E	300	1	0.33	R. Teale, unpublished.
1997	Mt Whaleback	23°21'S; 119°40'E	1790	1	0.06	Ecologia 1998a
1978–1981	Mount Keith	27°15'S; 120°30'E	1575	0	0	McKenzie *et. al.* 1994
1997–1998	Mount Keith	27°15'S; 120°30'E	3187	0	0	R. Teale, unpublished
2001	Mount Keith	27°15'S; 120°30'E	10400	33	0.32	R. Teale, unpublished
1996–1997	Tom Price area	22°42'S; 117°47'E	4500	0	0	R. Teale, unpublished
2001	Tom Price area	22°42'S; 117°47'E	unknown	4		Biota, 2002
2000	Meentheena	21°17'S; 120°28'E	2400	77	3.21	Kendrick unpublished
2001	Meentheena	21°17'S; 120°28'E	3420	138	4.04	Kendrick unpublished
2001	Hope Downs – Port Hedland Rail	22°59'S; 119°06'E	5360	44	0.82	R. Teale, unpublished

detected despite extensive prior trapping.

North eastern Pilbara

The first records of *P. desertor* from the Pilbara Bioregion came from the north-eastern corner on the Yarrie Plateau, approximately 10 kilometres southeast of Shay Gap. No *P. desertor* were recorded during trapping from 1993 and 1995, (including 400 trap-nights in March 1993, M Piggott *pers. comm.*; Table 2). Six captures were made in August 1996 from 970 Elliott trap nights, with a further five recorded from 2475 trap nights in November 1996. In July 1997, the last time trapping was conducted at this site, 17 captures were recorded from 2400 trap nights (R. Teale, unpublished).

At Meentheena, 100 kilometres south from the Yarrie Plateau where no *P. desertor* were trapped by Piggott in 1993–1995, trapping by P. Kendrick (unpublished) during 2000–2001 resulted in 215 captures of *P. desertor* from 2060 Elliott trap-nights and 3760 pit trap-nights.

South eastern Pilbara

Historically, considerable trapping effort has been conducted on iron ore tenements in the vicinity of Newman (23°21'S; 119°44'E). A survey at Ore Body 18 in August 1995 (ecologia 1995a) comprising 840 Elliott and 359 pit trap nights failed to capture any *P. desertor*, despite recording other rodent species in moderate numbers (10 *P. hermannsburgensis*, 31 *Zyzomys argurus*, and 4 *Mus musculus*). Similarly, five trapping episodes at Jimblebar (Endersby 1994) between October 1995 and October 1996, each deploying 3000 Elliott trap nights, failed to record any *P. desertor*, again despite capturing good numbers of other rodent species (*e.g.* in October 1996, 40 *P. chapmani*, 26 *P. hermannsburgensis*, 12 *Zyzomys argurus* and 16 *Mus musculus*, from 3000 trap nights). Earlier trapping surveys at the Ore Body 25 site in 1995 similarly failed to record any *P. desertor* (ecologia 1995b).

In August 1997 a single *P. desertor* was recorded in a survey of 590 Elliott trap nights and 1200 pit trap nights at Mount Whaleback, 5 km to the west of Newman (ecologia 1998a). In November 1997 a single individual was recorded from Mt Newman Ore Body 25 from 300 Elliott trap nights (Biota, unpublished data).

Central eastern Pilbara

Trapping in the area between Yarrie and Newman from August 1993 to August 1997, including Hope Downs (ecologia 1997), Marillana (22°42'S; 119°06'E: ecologia 1995b), Weeli Wolli Springs (22°48'S; 119°17'E: ecologia 1998b) and Mining Area C (22°56'S; 118°58'E: M. Piggott 1994, *pers. comm.* and BHP Iron Ore 1997) did not record *P. desertor*, despite over 10,000 Elliott trap nights and 4000 pit trap nights and moderate capture rates of other rodent species (e.g. eight

Pseudomys hermannsburgensis, 27 *Zyzomys argurus* and 32 *Mus musculus* at Weeli Wolli Springs during April 1995, (ecologia 1998b). The first records of *P. desertor* from this region came in November 1999, when six were captured from a number of sites adjacent to Weeli Wolli Creek (Halpern Glick Maunsell 2000).

Abydos – Woodstock Reserve

WA Museum staff systematically trapped 19 sites at Woodstock Station, covering 15 habitat types, over all seasons from March 1988 until November 1990 (How *et al.* 1990). From a total of 8131 Elliott and 2484 pit trap nights, no *P. desertor* were caught, though 292 specimens of other rodent species (*P. hermannsburgensis, P. chapmani, P. delicatulus, Mus musculus* and *Zyzomys argurus*) were captured. Ten years later, in 2000 and 2001, R. Teale (unpublished) trapped nine sites adjacent to the Newman to Port Hedland (BHP-Billiton) Rail, 10 kilometres west of Woodstock. Many sites shared comparable habitats to those sampled during the Woodstock Station survey. From a total of 470 Elliott and 1080 pit trap nights, R. Teale (unpublished) recorded seven *P. desertor*, in addition to three *Leggadina lakedownensis*, seven *M. musculus*, 26 *Z. argurus*, and 72 *P. hermannsburgensis*.

Hope Downs to Port Hedland

During a survey of the entire length of a proposed rail alignment from Hope Downs to Port Hedland, in which 33 sites were trapped in May, June to July and November 2001, 414 mammal captures were recorded from 4150 pit nights and 1210 Elliott trap nights. *P. desertor* was the third most commonly recorded species (44 captures) after *P. hermannsburgensis* (144) and *Ningaui timealeyi* (73). Other rodent captures included one *P. chapmani*, 12 *Notomys alexis*, 15 *Mus musculus*, 15 *Leggadina lakedownensis*, 18 *P. delicatulus* and 34 *Zyzomys argurus* (Biota 2001).

Central Pilbara

Pseudomys desertor was first recorded in the vicinity of Tom Price in March 2001 from the Southern Plains study area adjacent to the Tom Price Mine. Four *P. desertor* were recorded along with two *Leggadina lakedownensis*, 13 *Pseudomys hermannsburgensis*, 10 *P. chapmani*, one *Notomys alexis* and 9 *Mus musculus* (Biota 2002). No *P. desertor* were caught during extensive trapping by Biota in the vicinity of Tom Price during November 1996 and May, July and November 1997. In 1997, 300 pit traps were deployed, for a total of over 4500 pit-trap nights. Captures of other rodent species were comparable to those noted for the Hope Downs to Port Hedland survey in 2001 (e.g. in July 1997, two *Leggadina lakedownensis*, 30 *Pseudomys chapmani*, 11 *P. hermannsburgensis* and 14 *Mus musculus* were captured).

Dunlop and Sawle (1980) trapped within the Karijini (then Hamersley Range) National Park, and at three sites nearby, deploying 6333 trap nights between March 1979 and March 1981, and sampling during all months except January, February and August. No *P. desertor* were detected. Between 1991 and 1995, CALM established 23 trapping sites within the Karijini National Park, 50kilometres northeast of Tom Price, running from just north of Mount Bruce (22°36'S; 118°08'E) to north east of Mount Windell (22°39'S; 118°33'E). Nine sites were installed in 1991, and another 14 in 1995. The first nine were sampled for 16 nights each, the other 14 for 5 nights each, with pit and Elliott trap nights totalling 2568 and 3638 respectively. A total of 118 small mammals of 13 species (both dasyurids and rodents) were trapped in that time, but not one *P. desertor* was recorded (P. Kendrick unpublished).

AREAS SOUTH OF THE PILBARA

Mount Keith

No *P. desertor* were detected on Wanjarri Nature Reserve (near Mount Keith Station, 380 kilometres south of Newman), from 1575 trap nights deployed between 1978–1981 (McKenzie *et al.* 1994). Subsequently trapping for Mulgara (*Dasycercus cristicauda*) on Mount Keith station and on adjacent Barwidgee station (27°02'S; 120°55'E), carried out by R. Teale (unpublished) in 1997 and 1998, similarly did not record any *P. desertor* (March – June 1997, 1299 Elliott trap nights captured 7 *Dasycercus cristicauda*, 14 *P. hermannsburgensis* and 11 *Notomys alexis*; August – September 1998, 1888 Elliott trap nights captured 11 *Dasycercus cristicauda*, 52 *P. hermannsburgensis*, 40 *Notomys alexis* and 17 *Mus musculus*). However, during further trapping for Mulgaras by D. Pearson and A. Williams on Mount Keith from June – October 2001, 33 captures of 18 individual *P. desertor* (8 female, 10 male) were achieved from a total of 10400 Elliott trap nights (D. Pearson, *pers. comm.*).

Queen Victoria Spring

Alpers *et al.* (2003) recorded *P. desertor* at Queen Victoria Springs, in the Great Victoria Desert (30°04'S; 122°55.5'E), 190 kilometres south of the closest previous *P. desertor* record. This was the first record of *P. desertor* from this area, despite systematic mammal trapping between 1975 to 1985 by Burbidge, King, Pearson and Hart (Pearson *pers. comm.*), which resulted in 261 mammal specimens being lodged in the WAM. Pearson continued systematic trapping after this period until 2002 with no *P. desertor* captures.

RAINFALL DURING PERIOD COVERED IN THIS STUDY

Average annual rainfall figures

Table 3. Average annual rainfall figures for six localities in the Pilbara and Murchison Bioregions, as millimetres ± SD, standard deviation.

Locality	Long Term Average	Average 1988–1994	Total 1988–1994	Average 1995–2001	Total 1995–2001
Newman (Since 1970)	334±131 mm	245±63 mm	1716 mm	473±120 mm	3310 mm
Dampier Salt (Since 1970*)	260±113 mm	205±108 mm	1434 mm	356±41 mm	2136 mm
Port Hedland (Since 1943)	315±155 mm	309±194 mm	2162 mm	418±140 mm	2924 mm
Marble Bar (Since 1895)	360±155 mm	336±147 mm	2351	617±125 mm	4321 mm
Onslow (Since 1886†)	272±192 mm	281±86mm	1687 mm†	423±223 mm	2964 mm
Wiluna (Since 1899)	255±129 mm	226±94 mm	1583 mm	432±62 mm	3027 mm

* No data for 2001
† No data for 1988

for six localities in the Pilbara and Murchison Bioregions indicate that average falls during the period 1995 to 2001 were higher than the long term average for these centres (Table 3). For example, the long term average annual rainfall for Newman (records kept since 1970) is 333±131 mm, whilst that for the period 1995 – 2001 it was 473±120 mm. The seven years preceding 1995 were drier than average with just 245mm±63 mm. This is reflected in the cumulative total rainfall for these two periods: from 1988 – 1994 total rainfall was 1715mm, while the cumulative total for the 1995 – 2001 period was nearly double at 3310mm. However, perhaps more importantly, the rainfall was consistently higher than the long term average in each of the years following 1994. Other centres show a similar pattern.

DISCUSSION

Pseudomys desertor is a species with a high capacity to make a strong population response to favourable environments. It can feed on a wide variety of food types (including shoots, rhizomes, seeds, flowers and grasses) and is known to be able to survive without water in captivity (Watts and Aslin 1981). Murray *et al.* (1999) found that while *P. desertor* in the Simpson Desert was granivorous, those in the Tanami relied on non-seed plant material. As a dietary generalist, this species appears to be able to vary its diet both spatially and temporarily.

The broad ecological capacity and high fecundity of *P. desertor* (Reid *et al.* 1992) indicate that it may be able to respond to effective rainfall events in a more sustained way than sympatric granivorous rodents such as *Pseudomys hermannsburgensis*. *P. desertor* has a larger litter size, shorter gestation and weaning period, and younger age of sexual maturity (Yom-Tov 1985; Happold 1976a) than *P. hermannsburgensis*. Under laboratory conditions, breeding occurs all year (Kerle 1995), and this is supported by recent field observations from the Pilbara. Pregnant females were recorded from Meentheena (100 kilometres east of Marble Bar) in May and September, and at Yarrie (central Pilbara) in December and July. *Pseudomys desertor*, like other murine rodents of the semi-arid regions, can respond to "good" seasons by both increasing the number of young per litter, and the frequency of litters produced. (Kerle 1995; Taylor and Horner 1972). *Pseudomys desertor* in the Northern Territory responded by population irruption three to ten months after rain (Dickman *et al.* 1999), with the magnitude of the irruption correlated with the quantity and quality of available resources. Reid *et al.* (1992) show 24-fold increases in density of *P. desertor* within 3–10 months after rain near Uluru.

The dispersal ability of *P. desertor* may be enhanced by a social organisation dominated by intra-specific aggression (Happold 1976b). Individual small mammals in arid Australia are known to be capable of travelling up to 2km in a single night (Dickman *et al.* 1995, Letnic 2002).

Read *et al.* (1999) found *P. desertor* in a wide range of habitats in northern South Australia, including samphire shrubland, sedgeland and nitrebush (*Nitraria billardierei*) shrubland near mound springs, canegrass (*Zygochloa paradoxa*) on dunes, rocky hills, gibber plains and chenopod shrub-lands. Although capture rates could be low, *P. desertor* was present in all major habitat types in north-western South Australia, excepting woodlands and tall shrublands. Kutt *et al.* (2004) recorded *P. desertor* in a wide range of sub-tropical savanna woodland, shrubland and grassland vegetation types. In the Pilbara, *P. desertor* also shows a very broad range of habitat type (Table 1), including mulga and eucalypt woodlands, *Triodia* sandplains and rocky hills.

Pseudomys desertor appears able to cope with moderate disturbances from cattle and rabbits (Read *et al.* 1999), and from weeds (such as Buffel Grass), and may even be encouraged by some forms of disturbance (ODO 1994), but fire seems to have negative impacts, probably due to increased exposure to predation (Letnic *et al.* 2005; Masters 1993). *P. desertor* does not construct deep or complex burrows, and Dickman

(1993) found that in the Simpson Desert, *P. desertor* used burrows abandoned by other species. Further, the claims of Aitken (1972), Masters (1993) and Read *et al.* (1999) that *P. desertor* are partially diurnal are supported by our own observations. In November 1997, several *P. desertor* were observed running among *Triodia* clumps during mid-afternoon at Meentheena (two were captured) and in June 2000 an individual was observed moving between *Triodia* clumps early in the morning at Weeli Wolli Creek (Teale unpublished). If this is common behaviour, then their vulnerability to predation following fire would be high.

Systematic studies of the vertebrate fauna in the Pilbara region commenced in the late 1980s (How *et al.* 1990), and continued with government biologists and environmental consultants. The presence of *P. desertor* in the Pilbara bioregion prior to 1996 was sporadic and rare, and only on the eastern margins of the bioregion (the earliest WAM record is from East Bonithon Range, 20°21'S, 129°25'"E in 1967). Capture patterns in the Pilbara seem to indicate that either the geographic range or the detectability of this species has increased dramatically during the 1990's. The pattern of captures during the last 15 years is consistent with a steady westward movement of the species from the desert bioregions into the eastern, central and finally west Pilbara (the most westerly collections from near Pannawonica and Whim Creek are the most recent, Figure 1). The generalist habits and high reproductive potential of this species, combined with a known pattern of irruption following favourable conditions and a social system which encourages dispersal may support the inference that *P. desertor* has spread westward from the interior, and that this 'wave' may still be spreading. Alternatively, it is possible that the species has been present throughout its current distribution in numbers too low to be detected, or in refugia too localised to be encountered. In this case, the recent conspicuousness of *P. desertor* in the Pilbara may be due to an irruption by local populations in response to local conditions. From the information available it is impossible to determine which of these alternatives is correct. At least one other rodent species in the Pilbara shows great variation in detectability, apparently increasing in response to favourable conditions; *Leggadina lakedownensis* can be locally abundant and regionally widespread, and yet is almost undetectable during low-density periods (Teale and Kendrick unpublished). Nonetheless, despite considerable trapping effort, only five *P. desertor* were trapped in the Pilbara between 1992 and 1997, whereas in the period 1997 – 2002 a total of 404 *P. desertor* were trapped (Table 4).

Table 4. Numbers and dates of *Pseudomys desertor* captured in the Pilbara and Kimberley, Western Australia, from the Western Australian Museum (WAM) and Non-WAM biologists. Capture data of non-WAM biologists was collected only for 1992-2002 inclusive (dates with *).

Date	WAM records Pilbara	WAM records Kimberley	Non-WAM Pilbara captures
Pre 1992	8	6	
*1992–1996	5		
*1997–2002	71		333
2003–2006	62	6	

Great variation in abundance in *P. desertor* has been noted previously. Between 1990 and 1999 in the Simpson Desert, only 40 individuals of *P. desertor* were trapped in over 100,000 pitfall trapnights (Chris Dickman, *pers. comm.*). Following heavy rainfall in 2000 and 2001, over 600 *P. desertor* were trapped in 15,000 trap nights. Kutt *et al.* (2004) recorded many *P. desertor* within a zone with rainfall of 500–750mm. Similarly, prior to the reports of Read *et al.* (1999), no records of *P. desertor* had been reported from South Australia, Victoria or New South Wales since Aitken's (1972) record of abundant *P. desertor* at Anna Creek, South Australia. As in the recent records from the Pilbara, it is impossible to know whether *P. desertor* had geographically expanded from some remote location, or whether pre-irruption densities were too low to detect.

In a similar expansion westward of *P. desertor* in Western Australia, a great eastward expansion has been recorded in Queensland, hundreds of kilometres east of the previously known distribution, Kutt *et al.* (2004 and 2005). These studies found high abundance of *P. desertor* in its eastern distributional limit of central north Queensland was consistent with the presence of high native ground cover and the absence of fire and grazing.

Annual rainfall over north west and central Western Australia between 1995 and 2001 was well above the long term average (Table 3), and was approximately double that of the preceding 7 years. The years 1995 – 2001 correspond to the period in which large numbers of *P. desertor* were collected from the Pilbara. This sustained irruption of *P. desertor* is almost certainly in response to elevated rainfall, and thus more favourable conditions. It is of interest that the present extended distribution of *P. desertor* conforms closely with that of the distribution of subfossil material of this species (Figure 1).

Molecular techniques may

resolve the question of where these irruptive populations have come from. Many of the *P. desertor* lodged with the WAM have associated genetic tissue samples. Molecular analysis of these samples may provide an indication of whether *P. desertor* populations were widespread but disjunct prior to 1997, or alternatively that *P. desertor* have undertaken a massive and rapid expansion of range through central Western Australia, spreading westward from the interior.

CONCLUSIONS

As a result of extensive trapping of *Pseudomys desertor* since 1997, the extant geographic range of this species has been extended into areas where it was previously known only from sub-fossil material. It is unclear whether the recent appearance of *P. desertor* throughout the Pilbara is due to irruption of local inconspicuous populations widely but thinly distributed over this area, or whether the species has invaded the Pilbara from the interior, following high rainfall in the period 1995 – 2001.

From evidence presented here, it is clear that great variation can occur in the abundance and conspicuousness of rodent species in the semi-arid Pilbara. This pattern is not new, and has been widely reported in a variety of species. However, as a feature of episodic environments such as the Pilbara, we believe that this pattern must be considered by biologists and regulators in the assessment of environmental impact of developments, and in land management. The longterm conservation of irruptive species such as *P. desertor* may depend upon the persistence of what may be small, isolated refugia in very large landscapes. The identification and protection of such habitats presents a challenge to land managers in the Pilbara and elsewhere. Peak population areas should be monitored into subsequent periods of drought to determine which habitats become refuge areas.

This study was possible because of the vouchering of specimens for the WAM. The existence of associated genetic material with some specimens will permit future population studies which may resolve questions regarding range expansion and population increase.

ACKNOWLEDGEMENTS

We are grateful to Chris Dickman, John Dell, Robert Brandle, Ric How, Dave Pearson and Mark Cowan for constructive criticism of the manuscript; to Piers Higgs for Figure 1 and to Alex Baynes for information on subfossil distributions of *P. desertor*.

REFERENCES

AITKEN, P.F. 1972. *Planigale gilesi* (Marsupialia, Dasyuridae); a new

species from the interior of south eastern Australia. *Records of the South Australian Museum.* Supplement No 16 (10): 1–14.

ALPERS, D.L., GAIKHORST, G., LAMBERT, C., FLETCHER, T. and SPENCER, P.B.S. 2003. An extension to the known range of the Desert Mouse, Pseudomys desertor south into the Great Victoria Desert, Western Australia. *Australian Mammalogy* 25: 95–96.

BAYNES, A. 1990. The mammals of Shark Bay, Western Australia. *In: Research in Shark Bay. Report of the France-Australe Bicentenary Expedition Committee*, pp 313–325. Ed P.F. Berry, S.D. Bradshaw and B.R. Wilson. Western Australian Museum: Perth.

BHP IRON ORE 1997. Multiple Iron Ore Development Project. Public environmental Review. Mining Area C. November 1997.

BIOTA 2001. Proposed Hope Downs Rail Corridor from Weeli Wolli siding to Port Hedland – Vertebrate Fauna Survey. An unpublished report for Hope Downs Management Services, Perth.

BIOTA 2002. Southern Plains and Southern Detritals Fauna and Vegetation Monitoring 2001. An unpublished Report for Hamersley Iron Pty Ltd.

COOPER, N.K., TEALE, R.J., KENDRICK, P.G. and DURRANT, C. 2006. Identification of the Desert Mouse, *Pseudomys desertor* and the Chestnut Mouse, *Pseudomys nanus*. *Western Australian Naturalist* 25: 141–151.

DICKMAN, C.R. 1993. The Biology and management of native rodents of the Arid Zone in NSW. Species Management Report 12. NSW National Parks and Wildlife Service, Hurstville.

DICKMAN, C.R., PREDAVEC, M. and DOWNEY, F.J. 1995. Long-range movements of small mammals in arid Australia: implications for land management. *Journal of Arid Environments.* 31: 441–452

DICKMAN, C.R., MAHON, P.S., MASTERS, P. and GIBSON, D.F. 1999. Long term dynamics of rodent populations in arid Australia: the influence of rainfall. *Wildlife Research* 26: 389–403.

DICKMAN, C.R., LEUNG, L.K.P. and VAN DYCK, S.M. 2000. Status, ecological attributes and conservation of native rodents in Queensland. *Wildlife Research* 27: 333–346.

DUNLOP, J.N. and SAWLE, M. 1980. The small mammals of the Eastern Pilbara and the Hamersley Range National park. *In:* A fauna survey of the Hamersley Range National park Western Australia. *National Parks Authority of Western Australia.* Bulletin No 1. pp 26–30.

ECOLOGIA 1995a. Ore Body 18 Biological Assessment Survey. An unpublished report for BHPIO Pty Ltd.

ECOLOGIA 1995b. Ore Body 25 Biological Assessment Survey. An unpublished report for BHPIO Pty Ltd.

ECOLOGIA 1997. Hope Downs Biological Survey An unpublished report prepared for Hope Downs Management Services, Perth.

ECOLOGIA 1998a. Mt. Whaleback Fauna Monitoring Program: Baseline Sampling 1997–1998. An unpublished report for BHPIO Pty Ltd.

ECOLOGIA 1998b. Weeli Wolli Creek Biological Assessment Survey An unpublished report for BHPIO Pty Ltd.

ECOLOGIA 1998c. West Angelas Borefield Pipeline Corridor Fauna Assessment Survey. An unpublished report for Robe River Mining Co. Pty. Ltd.

ENDERSBY, M. 1994. Jimblebar Mine Site Biological Survey. An unpublished report for BHPIO Pty Ltd.

HALPERN GLICK MAUNSELL. 1998. Yarrie Crustal Deposits Baseline Biological and Soil Survey. An unpublished report for BHP Iron Ore Pty. Ltd.

HALPERN GLICK MAUNSELL 2000. Hope Downs Rail Corridors Biological Survey. Unpublished report for Hope Downs Management Services, Perth.

HAPPOLD, M. 1976a. Reproductive Biology and development in the conilurine rodents (Muridae) of Australia. *Australian Journal of Zoology.* 24: 19–26.

HAPPOLD, M. 1976b. Social behaviour of the conilurine rodents (Muridae) of Australia. *Zeitschrift fur Tierpsychologie.* 40: 113–182.

HAPPOLD, M. 1983. Desert Mouse. *In : Complete Book of Australian mammals.* Ed. R. Strahan. Pp 402–403. Angus & Robertson: Sydney.

HOW, R.A. and COOPER, N.K. 2002. Terrestrial and small mammal fauna of the Abtydos Plain in the north-eastern Pilbara, Western Australia. *Journal of the Royal Society, Western Australia.* 85: 71–82.

HOW, R.A., DELL, J. and COOPER, N.K. 1990. Vertebrate Fauna. *In* Ecological survey of Abydos-Woodstock Reserve, Western Australia. *Records of the Western Australian Museum.* Supplement No 37: 78–125.

KERLE, J.A. 1995. Desert Mouse, *Pseudomys desertor.* Pp 594–5. *In*: R. Strahan (ed) *Mammals of Australia.* Australian Museum/ Reed Books, Sydney.

KUTT, A.S., THURGATE, N.Y. and HANNAH, D.S. 2004. Distribution and habitat of the desert mouse (*Pseudomys desertor*) in Queensland. *Wildlife Research.* 31: 129–42.

KUTT, A.S., JEMP, J.E., MCDONALD, K.R., WILLIAMS, Y., WILLIAMS, S.E., HINES, H.B., HERO, J.M. and TORR, G. 2005. Vertebrate fauna survey of White Mountains National Park in the Desert Uplands Bioregion, central-north Queensland. *Australian Zoologist.* 33: (1) 17–38.

LETNIC, M. 2002. Long distance movements and the use of fire mosaic by small mammals in the Simpson Desert, Central Australia. *Australian Mammalogy* 23: 125–134.

LETNIC, M., TAMAYO, B. and DICKMAN C.R. 2005. The responses of mammals to La Nina (EL Nino Southern Oscillation)-associated rainfall, predation, and wildfire in Central Australia.

Journal of Mammalogy. 86 (4): 689–703.

MCKENZIE, N.L., ROLFE, J.K. and YOUNGSON, W.K. 1994. Vertebrate Fauna. *In*: The biological survey of the eastern goldfields of Western Australia. Part 10: Buntine, Nugadong, and east Nugadong Nature Reserves and Nugadong Forest Reserve. *Records of the Western Australian Museum*, Supplement No. 47. 51–85.

MCKENZIE, N.L., HALL, N. and MUIR, W. P. 2000. Non-volant mammals of the southern Carnarvon Basin, Western Australia. Appendix 1, p505. *Records of the Western Australian Museum*, Supplement No. 61.

MASTERS, P. 1993. The effects of s-driven succession and rainfall on small mammals in spinifex grassland at Uluru National park, Northern Territory. *Wildlife Research* 20: 803–13.

MURRAY, B.R., DICKMAN, C.R., WATTS, C.H.S. and MORTON, S.R. 1999. The dietary ecology of Australian desert rodents. *Wildlife Research* 26: 421–437.

ODO 1994. Environmental Management Programme. Annual Report 01/03/93–28/02/94. Olympic Dam Operations, Olympic Dam.

READ, J., COPLEY, P. and BIRD, P. 1999. The distribution, ecology and current status of *Pseudomys desertor* in South Australia. *Wildlife Research* 26: 453–462.

REID, J.R.W., KERLE, J.A. and MORTON, S.R. 1992. The distribution and abundance of vertebrate faunaof Uluru (Ayers Rock- Mount Olga) National Park. *Kowari* No 4. ANPWS

REID, J.R.W., KERLE, J.A. and BAKER, L. 1993. Mammals. *In* 'Uluru fauna .The distribution and abundance of vertebrate fauna in Uluru National Park, N.T., Australian National Parks and Wildlife Service: Canberra.

TAYLOR, J.M. and HORNER, B.E. 1972. Observations on the reproductive biology of *Pseudomys* (Rodentia: Muridae). *Journal of Mammalogy* 53: 318–328

WATTS, C.H.S. and ASLIN, H.J. 1981. *The Rodents of Australia*. Angus & Robertson Sydney.

WESTERN AUSTRALIAN MUSEUM 2003. FaunaBase. www.museum.wa.gov.au/FaunaBase

YOM-TOV, Y. 1985. The reproductive rates of Australian rodents. *Oecologica* 66: 250–255